

Artificial Selection and Biodiversity

Part 1: The Perfect Cow?

Introduction

Cattle evolved through the slow process of natural selection until human domestication, which rapidly accelerated their development as an artificially selected species fit less for survival than to satisfy human needs. How and why have humans been so successful in selectively breeding cattle to suit their needs, but what are the limitations and consequences of this success?

Step 1: View the video clip “A Cow’s Digestive System” (all clips in this part of the assignment can be found at <http://www.pbs.org/wnet/nature/lessons/the-perfect-cow/video-segments/1536/>).

Questions:

a) Does this clip illustrate naturally or artificially selected attributes?

The video clip illustrates naturally selected attributes of the cow, due to the fact that the cow has developed a unique digestive system in order to digest grass, which is their main source of food. The clip illustrates how the digestive system functions and how it contains a substantial role in the domestication of the cow. Also, the clip illustrates naturally selected attributes primarily because the unique digestive system that is in the cow was developed by adaptation to their environment. Evidently, the fittest cows contained the unique digestive system, creating the potential to pass on the genes for the formation of the digestive system to offspring. Therefore, the clip illustrated naturally selected attributes of the cow.

b) Why would a cow’s ability to eat grass make it ideal for human domestication?

The cow’s ability to eat grass would make it ideal for human domestication due to the fact that the cow depends only on autotrophic organisms to survive, instead of other organisms, and can consume a variety of foods. This creates the ability for domestication, since cow’s are only dependent on a single resource to sustain life. Not only do cow’s require a single natural resource to survive, they also contain unique digestive characteristics that assist in the every day living of human organisms, by the production of dairy products. The vitamins and nutrients found in the products, assist in bodily function. For these reasons, the cow’s ability to consume grass make it ideal for human domestication.

c) How do you think the domestication of animals affects the process of natural selection?

The domestication of animals affects the process of natural selection due to the fact that domestication alters the genetic construction of the animal, in order to portray certain traits that will benefit living. This being stated, adaptation does not occur within the organism, having an effect on the entire species. Also, with domestication, the amount of offspring produced do not have to fight to sustain survival, indicating that the genes of every offspring are passed on, and not just the genes of the organism with a strong fitness. Also, the individuals of the population do not vary, creating little variation within the population. Therefore, with domesticated organisms, natural selection doesn’t

contain as much of an impact on the animals.

Key = domestication provides all necessary resources for survival. Therefore, there is no struggle for survival, no competition for resources!

Step 2: View the video clip “Desirable Breeding Traits In Cattle”.

Question:

a) What are some specific traits humans have artificially selected in cows to give them certain desirable attributes? Consider both beef and dairy cattle.

In the beef cow, especially in America the cattle have been artificially selected to have short legs and have large amounts of beef and meat on their frame. For the dairy cow the teats are located in the ideal position, the legs are centered on the body, and the cow produces 50 to 60 pints of milk per day.

Step 3: View the video clip “Different Breeds of Cattle”.

Question:

a) What other characteristics besides meat and milk volume might be desirable to breed into cattle?

Other characteristics besides meat and milk volume that might be desirable to breed into cattle might be the fur of the animal, and the texture of the fur. Also, the characteristic of strength are desired to breed into cattle, along with the production of other dairy products besides milk such as cheese. The ability of adaptation to the environment may also be a desired trait for cattle, due to the fact that the cattle with greatest adaptation has the potential to survive in a variety of environments. These are other characteristics beside meat and milk volume that might be desirable to breed into cattle.

Step 4: Go to the “Genetic Engineering” web site

(<http://regentsprep.org/Regents/biology/units/heredity/engineering.cfm>), read the “Selective Breeding” section and view the 3 breeds of cows shown. You don’t need to read any further.

Questions:

a) Define the term “hybridization”.

The term hybridization by definition is a special case of selective breeding that involves crossing two individuals with different desirable traits to produce offspring with a combination of both desirable traits.

b) Do you think that selectively breeding hybrid cattle can produce the “perfect cow”? Why or why not?

Opinion question - answers will vary. Good answers are backed up with good reasons and by making reference to adaptation and processes of selection. Consider the fact that selective breeding produces individuals best suited for a certain environment and it's set of conditions, and for the needs that we have at that time. What happens to our “perfect cow” when the environment or our needs change? Consider what can happen to a species when genetic variation is reduced.

Step 5: Read the article “A Dying Breed” (attached, or can be found at <http://www.nytimes.com/2008/01/27/magazine/27cow-t.html>). This article will take you some time to read. As you read the article, fill out the organizer table “Traits of Ankole and Holstein Cattle Student Organizer” that is below.

Task: Imagine you are a Bahiman person in Uganda. Consider four socio-economic groups: traditional nomadic cattle herders, settled dairy farmers, settled cattle ranchers, and wealthy politicians. Considering the needs and desires of each Bahiman group, would they want to cross-breed their Ankole cattle with Holstein cattle (which would be provided by an international aid organization)? What are the social and economic compromises or risks involved?

Organizer Table:

**“Traits of Ankole and Holstein Cattle”
Student Organizer**

	Ankole	Holstein
How does the article describe each breed's hardiness?	<i>“tough”</i>	<i>“fussy”</i>
Does this breed produce more or less milk than the other breed?	<i>Less</i>	<i>More (20-30 times more milk than the Ankole)</i>
Has the animal been mainly bred through natural or artificial selection?	<i>Natural selection</i>	<i>Artificial selection (selective breeding, artificial insemination)</i>

Is this breed's appeal more traditional or commercial?	<i>Traditional. The once-nomadic Bahimans herded the Ankole for centuries.</i>	<i>Commercial. Poor Bahimans now want more productive breeds like the cattle to feed their settled, increasingly westernized, and rapidly growing population.</i>
Is this breed well adapted to the hot climate of Uganda?	<i>Yes. It's horns radiate excess heat.</i>	<i>No</i>
Does this breed have resistance to tropical diseases?	<i>Yes</i>	<i>No. Holsteins are often sick, and require expensive imported medicines.</i>
Does this breed eat more or less grass than the other?	<i>Less</i>	<i>More. In Uganda, they are often hungry, and require supplemented diets.</i>
Does this breed require more or less water than the other?	<i>Less, which makes them better adapted to Uganda's dry climate.</i>	<i>More</i>
Does this breed live in the open or in captivity?	<i>Ankoles require open land in which to roam (just like their traditionally nomadic masters once did.)</i>	<i>Can be kept in privately owned pens as part of the Bahimans' new settlements.</i>
Does this breed produce quality meat?	<i>Yes. Tender and "free range".</i>	<i>Unclear from the article, but it does point out the Holsteins are popular throughout the world for their meat as well as their milk.</i>

Questions:

a) Which of the four groups of people would want to cross breed Ankole and Holstein cattle? Explain your reasoning.

The group which would want to cross breed Ankole and Holstein cattle would be the settled dairy farmers of Uganda. Cross breeding the Ankole and Holstein creates a cow that will benefit the agricultural workers in Uganda. As it states in the article, one of the Uganda dairy farmers Kevina was able to make 100 dollars a month after expenses, which is a substantial income when 85 percent of the population makes 1 dollar a day. With this substantial income, dairy farmers have the ability to purchase wonderful housing and can live comfortably. The prime minister of Uganda, also states that, "They have tasted the money," and that, "They are excited about having these big earnings, and they have forgotten the cultural aspect," (4). Obviously, the dairy industry is interested in cross breeding Ankole cattle and Holstein cattle in order to receive a greater income. This is the group that would want to cross breed the Ankole cattle and the Holstein cattle.

b) What are compromises or risks involved in cross breeding these two breeds of cattle?

The compromises involved in cross breeding these two breeds of cattle would involve the creation of a incredible type of cow. The Ankole cattle contains beneficial traits such as the ability to survive in extreme climate and the immunity to tropical illnesses. Also, the Ankole consumes less amounts of grass then the average cattle. The Holstein cattle are incredible when at milk production and also contain a high quality of meat. Also, the adaptivity level of the Holstein is wonderful, indicating tat it can live a variety of climates. Cross breeding these cattle will produce a cow with fantastic milk production and will also create a cow with the ability to survive the hot climate of Uganda. Also, the cow produce will create a higher quality of beef. The risks involved in cross breeding these two breeds of cattle is that the cross breeding of the Ankole and the Holstein may create the Ankole to become threatened or possibly even extinct. This extinction has a significant to all organisms and even the humans that rely on the Ankole to produce a variety of products. Also, the crossing between the Ankole and Holstein could create overgrazing, due to the fact that the Holstein consumes larger quantities of grass then the Ankole. This also has a substantial impact on other living organisms in the environment. These are the compromises and risks involved with the cross breeding of two different breeds of cattle.

c) Has your opinion about whether selective breeding of hybrid cows can produce the “perfect cow” changed? Why or why not?

Opinion question - answers will vary. Answers should make reference to the story about Ankoles and Holsteins in Uganda.

Part 2: Artificial Selection of Crops and Biodiversity

Read the article “Seeds of Evolution” (found at

<http://www.guardian.co.uk/commentisfree/2009/feb/16/charles-darwin-scienceofclimatechange>).

Questions:

a) What aspect of Darwin’s Theory of Natural Selection is plant breeding altering? Explain.

The aspects of Darwin’s Theory of Natural Selection that plant breeding is altering is the variation of species. Plant breeders continue to set different autotrophic organisms in different environments for complete adaptation. The adaptive traits are used for crop growing by farmers in the future. In performing this, the ability to create variation in organisms will be terminated. This lack of variation will have a significant impact on the agricultural industry and humans as a whole.

b) Considering the global food crisis, how would you suggest we embrace our “evolutionary responsibility”?

Answers will vary here depending on your opinion. It’s important that if you are in favour of selecting certain organisms for breeding that all the “wild” and “native” genes are preserved as well. By cataloguing the genes of all species on Earth, scientists are

attempting to do this. However, we also need to keep in mind that people are not getting enough nutrient rich food to eat. How can we balance these two needs? An important question for all of us to consider.....

Part 3: Go to the following website and read the Introduction, Biodiversity, and Conclusions sections.

<http://sitemaker.umich.edu/africa.gmo/introduction>

Questions:

a) How do genetically modified crops benefit impoverished nations?

Genetically modified crops benefit impoverished nations due to the fact that genetically modified crops have a beneficial impact on the total number of plant species. Also, genetically modified crops are draught resistant and are possibly resistant to a numerous pesticides. As long as genetically modified crops are inexpensively available to Africa, it could create some relief of starvation. Also, genetically modified crops are less labour intensive. These are just a few examples of how genetically modified crops benefit impoverished nations

b) Explain why genetically modified crops threaten biodiversity in Africa?

Genetically modified crops threaten biodiversity in Africa due to the fact that genetically modified crops create environmental dilemmas such as super weeds, extinction of native crops and of pests. Developing super weeds would create farming to be difficult and threaten delicate plants in other parts of Africa. Some of the weeds found contain the potential to be pest resistant. Genetically modified crops could wipe out native crops of Africa.